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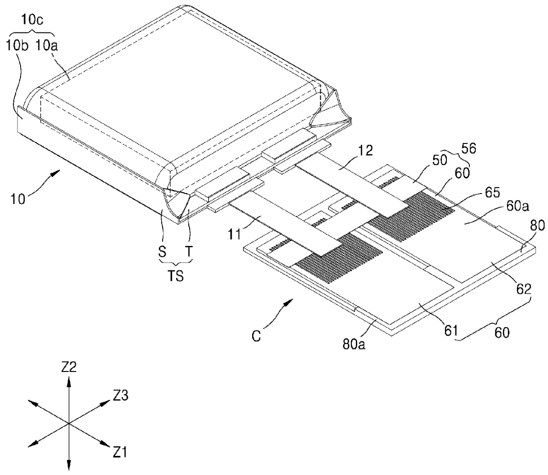
(54) BATTERY PACK

(57) A battery pack is provided. The battery pack includes a battery cell including an electrode extending in a first direction, a circuit portion connected to the electrode of the battery cell, and a connection portion forming a connection between the electrode of the battery cell and the circuit portion, the connection portion including a conductive thermocompression bonding layer and a conductive pad layer having a concave accommodation space formed in a second direction intersecting with the first direction to accommodate a portion of the conductive thermocompression bonding layer. According to the disclosure, a battery pack in which a connection process may be easily performed while increasing reliability of an electrical connection between a battery cell and a circuit portion forming a charge and discharge path of the battery cell may be provided.

FIG. 1



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Description

BACKGROUND

1. Field

[0001] One or more embodiments relate to a battery pack.

2. Description of the Related Art

[0002] In general, secondary batteries are batteries that can be charged and discharged, unlike primary batteries that cannot be charged. Secondary batteries are used as energy sources for mobile devices, electric vehicles, hybrid vehicles, electric bicycles, uninterruptible power supply, etc. Secondary batteries may be used in the form of a single battery or in the form of a module bundled as a unit by connecting a plurality of batteries, depending on the type of external device to be applied.

SUMMARY

[0003] One or more embodiments include a battery pack in which a connection process may be easily made while increasing reliability of an electrical connection between a battery cell and a circuit portion forming a charge and discharge path of the battery cell.

[0004] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments of the disclosure.

[0005] According to one or more embodiments, a battery pack includes: a battery cell including an electrode extending in a first direction; a circuit portion connected to the electrode of the battery cell; and a connection portion forming a connection between the electrode of the battery cell and the circuit portion, the connection portion including a conductive thermocompression bonding layer and a conductive pad layer having a concave accommodation space formed in a second direction intersecting with the first direction to accommodate a portion of the conductive thermocompression bonding layer.

[0006] The electrode may include a first electrode and a second electrode, arranged in a third direction intersecting with the first and second directions, the first and second electrodes having different polarities, wherein the conductive pad layer may include a first conductive pad layer and a second conductive pad layer, which are apart from each other in the third direction so as to be connected to the first electrode and the second electrode, respectively.

[0007] The conductive thermocompression bonding layer may be continuously formed in the third direction between the first electrode and the first conductive pad layer and between the second electrode and the second conductive pad layer.

[0008] The conductive thermocompression bonding layer may be between the electrode of the battery cell and the conductive pad layer in the second direction.

[0009] The conductive pad layer may include a convex portion relatively protruding in the second direction and a concave portion relatively concave in the second direction.

[0010] The concave portion may provide the concave accommodation space.

[0011] The conductive thermocompression bonding layer may include conductive particles supported on the convex portion and an insulating resin accommodated in the concave portion.

[0012] The convex portion and the concave portion may extend in parallel in the first direction.

[0013] The convex portion and the concave part include the same metal material.

[0014] The conductive pad layer may include an uneven pattern in which the convex portion and the concave portion are alternately arranged in a third direction intersecting with the first and second directions.

[0015] The uneven pattern may be formed at a position biased close to a front position of the conductive pad layer facing the battery cell.

[0016] The uneven pattern may be completely surrounded by an edge portion of the conductive pad layer.

[0017] An insulating layer may be formed around the conductive pad layer.

[0018] At least some of edge portions of the conductive pad layer forming a boundary between the conductive pad layer and the insulating layer may form a step so that an upper surface of the conductive pad layer protrudes more prominently than an upper surface of the insulating layer in the second direction.

[0019] The step may be formed around an uneven pattern formed on the conductive pad layer.

[0020] The step may be formed around the conductive thermocompression bonding layer.

[0021] The edge portions of the conductive pad layer may include: a front edge portion formed at a position relatively close to the battery cell in the first direction; a rear edge portion formed at a position relatively far from the battery cell in the first direction; and a side edge portion connecting the front edge portion to the rear edge portion.

[0022] The step may be formed in a front portion of the side edge portion overlapping the uneven pattern in a third direction intersecting with the first and second directions.

[0023] The step may be formed in a front portion of the side edge portion overlapping the conductive thermocompression bonding layer in a third direction intersecting with the first and second directions.

[0024] The step may be formed in the front edge portion relatively close to the battery cell in the first direction.

[0025] At least some of the above and other features of the invention are set out in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The above and other aspects, features, and advantages of certain embodiments of the disclosure will be more apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view of a battery pack according to an embodiment of the disclosure;
FIG. 2 is an exploded perspective view of the battery pack shown in FIG. 1;
FIG. 3 is a perspective view of a portion of the battery pack shown in FIG. 1;
FIG. 4 is a cross-sectional view taken along line IV-IV of FIG. 3;
FIG. 5 is a perspective view of a portion of the battery pack shown in FIG. 1;
FIG. 6 is a plan view of a portion of the battery pack shown in FIG. 5;
FIG. 7 is a perspective view of a portion of the battery pack shown in FIG. 1; and
FIGS. 8A and 8B illustrate the structures of a comparative example and an embodiment of the disclosure for measuring a connection resistance value between an electrode of a battery cell and a conductive pad layer, as an experiment for showing technical effects of an embodiment of the disclosure.

DETAILED DESCRIPTION

[0027] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. In this regard, the present embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the embodiments are merely described below, by referring to the figures, to explain aspects of the present description. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. Expressions such as "at least one of," when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0028] Hereinafter, a battery pack according to an embodiment of the disclosure will be described with reference to the accompanying drawings.

[0029] FIG. 1 is a perspective view of a battery pack according to an embodiment of the disclosure. FIG. 2 is an exploded perspective view of the battery pack shown in FIG. 1.

[0030] FIG. 3 is a perspective view of a portion of the battery pack shown in FIG. 1. FIG. 4 is a cross-sectional view taken along line IV-IV of FIG. 3. FIG. 5 is a perspective view of a portion of the battery pack shown in FIG. 1. FIG. 6 is a plan view of a portion of the battery pack shown in FIG. 5. FIG. 7 is a perspective view of a portion of the battery pack shown in FIG. 1.

[0031] Referring to FIGS. 1 and 2, a battery pack according to an embodiment of the disclosure may include a battery cell 10 including electrodes 11 and 12 extending in a first direction Z1, a circuit portion C connected to the electrodes 11 and 12 of the battery cell 10, and a connection portion 56 for forming a connection between the electrodes 11 and 12 of the battery cell 10 and the circuit portion C, the connection portion 56 including a conductive thermocompression bonding layer 50 and a conductive pad layer 60 having a concave accommodation space formed in a second direction Z2 intersecting with the first direction Z1 to accommodate a portion of the conductive thermocompression bonding layer 50.

[0032] The battery cell 10 may include an electrode assembly 10a, a casing 10b surrounding the electrode assembly 10a, and the electrodes 11 and 12 drawn out from the casing 10b. Although not shown in the drawings, the electrode assembly 10a may be formed in a winding type in which first and second electrode plates and a separator between the first electrode plate and the second electrode plate are wound in a roll shape. Alternatively, the electrode assembly 10a may be formed in a stacked type in which the first and second electrode plates and the separator are stacked on each other. The first and second electrode plates of the electrode assembly 10a may be electrically connected to the outside of the casing 10b through the electrodes 11 and 12 of the battery cell 10. The electrodes 11 and 12 of the battery cell 10 may be electrically connected to the first and second electrode plates of the electrode assembly 10a, respectively, and may include a first electrode 11 and a second electrode 12, which have different polarities.

[0033] The casing 10b may be formed to surround the electrode assembly 10a, and by sealing an excess portion of the casing 10b remaining after surrounding the electrode assembly 10a, a sealing portion TS for sealing the electrode assembly 10a may be formed. In this case, the battery cell 10 may include a body 10c including the electrode assembly 10a and the casing 10b surrounding the electrode assembly 10a, and a sealing portion TS formed along the periphery of the body 10c and including the casing 10b for sealing the electrode assembly 10a. In this case, the sealing portion TS may include the terrace portion T from which the electrodes 11 and 12 are drawn out, and may include, in addition to the terrace portion T, a side sealing portion S formed along the side of the body 10c of the battery cell 10.

[0034] The electrodes 11 and 12 of the battery cell 10 may be drawn out through the terrace portion T, and may be electrically connected to the circuit portion C through the connection portion 56, as will be described later. In an embodiment of the disclosure, the electrodes 11 and 12 of the battery cell 10 may extend in the first direction Z1, and may be electrically connected to the circuit portion C arranged at a front position of the battery cell 10 in the first direction Z1.

[0035] In an embodiment of the disclosure, the first direction Z1 may mean a direction in which the electrodes 11 and 12 of the battery cell 10 extend, or may mean a direction in which the battery cell 10 and the circuit portion C are arranged, or a direction in which the battery cell 10 and the circuit portion C face each other. In this case, the front position of the battery cell 10 in the first direction Z1 may mean a front position of the battery cell facing the circuit portion C. Similarly, the front position of the circuit portion C in the first direction Z1 may mean a front position of the circuit portion C facing the battery cell 10.

[0036] The electrodes 11 and 12 of the battery cell 10 may include the first electrode 11 and the second electrode 12, arranged in a third direction Z3, and as will be described later, the first and second electrodes 11 and 12, which have different polarities, may be respectively connected to first and second conductive pad layers 61 and 62 arranged on the circuit portion C. A detailed technical configuration of the conductive pad layer 60 including the first and second conductive pad layers 61 and 62 will be described later in more detail.

[0037] The circuit portion C may form a charge and discharge path of the battery cell 10. In an embodiment of the disclosure, the circuit portion C is to form a charge and discharge path connected to the electrodes 11 and 12 of the battery cell 10, and may form a charge and discharge path between the battery cell 10 and an external device. In an embodiment of the disclosure, the external device may correspond to an external load receiving discharge power from the battery cell 10 or an external charger providing charging power toward the battery cell 10, and the circuit portion C may form a discharge path from the battery cell 10 to an external load or form a charge path from an external charger to the battery cell 10. In various embodiments of the disclosure, the circuit portion C may include the entire charge and discharge path between the battery cell 10 and an external device, or may include only a portion of the charge and discharge path between the battery cell 10 and the external device.

[0038] When the battery pack according to an embodiment of the disclosure includes the circuit portion C electrically connected to the battery cell 10, the circuit portion C may include the entire charge and discharge path between the battery cell 10 and an external device, or may include only a portion of the charge and discharge path between the battery cell 10 and the external device. For example, the battery pack according to an embodiment of the disclosure may include, as the circuit portion C electrically connected to the battery cell 10, various components as long as the circuit portion C is electrically connected to the battery cell 10 to form a charge and discharge path of the battery cell 10, and may not necessarily include all components connected to an external device.

[0039] The circuit portion C according to an embodiment of the disclosure may include a circuit board connected to the battery cell 10, that is, a circuit board having a conductive line for forming a charge and discharge path of the battery cell 10, such as a rigid circuit board including a relatively rigid insulating substrate or a flexible insulating board including a relatively soft insulating film. On the circuit board, a circuit element (not shown), which is capable of obtaining state information such as the voltage, current, and temperature of the battery cell 10 or is capable of controlling the charging and discharging operations of the battery cell 10 based on the obtained state information of the battery cell 10, may be arranged. In the drawings attached to this specification, the circuit portion C may include a circuit board including an insulating layer 80, and a conductive line (not shown) for forming a charge and discharge path of the battery cell 10 may be formed on the circuit board. In an embodiment of the disclosure, the conductive line (not shown) may extend from the connection portion 56 connected to the electrodes 11 and 12 of the battery cell 10. When it is assumed throughout the present specification that the connection portion 56 forms a conductive connection between the electrodes 11 and 12 of the battery cell 10 and the circuit portion C, it may mean that the connection 56 forms a conductive connection between the electrodes 11 and 12 of the battery cell 10 and a conductive line of the circuit board, for example, a conductive line formed on the insulating layer 80.

[0040] In an embodiment of the disclosure, the circuit portion C may include a safety element (not shown) prepared on the charge and discharge path of the battery cell 10 and capable of blocking charge and discharge current of the battery cell 10 by capturing abnormal conditions such as overheating, overcharging, and overdischarging of the battery cell 10. For example, in an embodiment of the disclosure, in order to forcibly reduce or block the charge and discharge current according to the overheating of the battery cell 10 when the battery cell 10 is overheated above a preset threshold temperature, the safety element (not shown) may be prepared on the charge and discharge path of the battery cell 10 and include a variable resistor having resistance that varies with temperature. For example, in an embodiment of the disclosure, the safety element may include a positive temperature coefficient (PTC), a thermal cut-off (TCO), or the like.

For example, the circuit portion C may include both a circuit board on which a conductive line for forming a charge and discharge path of the battery cell 10 is formed and a safety element (not shown) arranged on the circuit board, or may include only a safety element (not shown) that is not supported by the circuit board.

[0041] In an embodiment of the disclosure, the connection portion 56 may be between the battery cell 10 and the circuit portion C. The connection portion 56 may be between the battery cell 10 and the circuit portion C to form an electrical connection therebetween. In an embodiment of the disclosure, the connection portion 56 may include a conductive thermocompression bonding layer 50 and a conductive pad layer 60 having a concave accommodation space formed in the second direction Z2 to accommodate a portion of the conductive thermocompression bonding layer 50. In an embodiment of the disclosure, the second direction Z2 may refer to a thickness direction of the conductive thermocompression bonding layer 50 or a thickness direction of the conductive pad layer 60, and may refer to a direction in which the conductive thermocompression bonding layer 50 is compressed or a direction in which the conductive pad layer 60 is compressed. The second direction Z2 may correspond to a direction intersecting with the first direction Z1 in which the electrodes 11 and 12 of the battery cell 10 extend and the third direction Z3 in which the electrodes 11 and 12 of the battery cell 10 are arranged. In an embodiment of the disclosure, the second direction Z2 may correspond to a direction perpendicular to the first and third directions Z1 and Z3.

[0042] Referring to FIGS. 3 and 4, the conductive thermocompression bonding layer 50, which forms an electrical connection between the battery cell 10 and the circuit portion C, may have conductivity through thermocompression bonding between the battery cell 10 and the circuit portion C. In an embodiment of the disclosure, the conductive thermocompression bonding layer 50 may refer to a component that does not have conductivity before thermocompression bonding, but have conductivity through thermocompression bonding. The conductive thermocompression bonding layer 50 according to an embodiment of the disclosure is different from a metal member that may be recognized as a conductive material regardless of thermocompression bonding, and may refer to a component in which conductivity thereof may be differentiated before thermocompression bonding and after thermocompression bonding. That is, in an embodiment of the disclosure, the conductive thermocompression bonding layer 50 may form an electrical connection between the electrodes 11 and 12 of the battery cell 10 and the circuit portion C through the conductive transition of the conductive thermocompression bonding layer 50, that is, a transition from a non-conductive state (or an insulating state) before thermocompression bonding to a conductive state after thermocompression bonding. Throughout the present specification, the conductive transition of the conductive thermocompression bonding layer 50 may refer to a transition from a non-conductive state (or an insulating state) before thermocompression bonding to a conductive state after thermocompression bonding, and may refer to a transition to a conductive state through thermocompression bonding.

[0043] In a specific embodiment of the disclosure, the conductive thermocompression bonding layer 50 may include conductive particles 51 and an insulating resin 52 accommodating the conductive particles 51. In an embodiment of the disclosure, the insulating resin 52 may be in a solid phase below a transition temperature to thereby fix the conductive particles 51, and above the transition temperature, the insulating resin 52 may be changed to a liquid or gel phase that may have fluidity other than a solid phase and thus the conductive particles 51 dispersed in the insulating resin 52 may have fluidity. The conductive particles 51 having fluidity may be arranged between the electrodes 11 and 12 of the battery cell 10 and the circuit portion C to form a conductive connection. For example, as the insulating resin 52, which has fluidity above the transition temperature, is pushed out between the electrodes 11 and 12 of the battery cell 10 and the circuit portion C by a pressure provided with heat, that is, a pressure provided in the second direction Z2 to make the electrodes 11 and 12 of the battery cell 10 and the circuit portion C approach each other, the remaining conductive particles 51 may electrically connect the electrodes 11 and 12 of the battery cell 10 to the circuit portion C.

[0044] The conductive pad layer 60 may be formed on the circuit portion C facing the electrodes 11 and 12 of the battery cell 10, and together with the conductive thermocompression bonding layer 50, the conductive pad layer 60 may form the connection portion 56 electrically connecting the battery cell 10 to the circuit portion C. In this case, the conductive pad layer 60 may help a conductive transition of the conductive thermocompression bonding layer 50 so that the conductive transition of the conductive thermocompression bonding layer 50 may be smoothly performed. Hereinafter, a configuration, in which the conductive thermocompression bonding layer 50 and the conductive pad layer 60, which form the connection portion 56, cooperate with each other to form a conductive connection between the electrodes 11 and 12 of the battery cell 10 and the circuit portion C according to thermocompression bonding, will be described.

[0045] The conductive pad layer 60 may include a convex portion 65a that is relatively protruded in the second direction Z2, and a concave portion 65b that is relatively concave in the second direction Z2. In this case, the second direction Z2 may correspond to a thickness direction of the conductive pad layer 60, and may correspond to a direction in which the conductive thermocompression bonding layer 50 is compressed, as will be described later. The conductive pad layer 60 may have a configuration that may help the conductive transition of the conductive thermocompression bonding layer 50. For example, the convex portion 65a may provide a support base that supports the conductive particles 51 of the conductive thermocompression bonding layer 50, and the concave portion 65b may provide a concave accommodation space capable of accommodating the insulating resin 52 of the conductive thermocompression bonding layer 50.

[0046] In an embodiment of the disclosure, the convex portion 65a and the concave portion 65b of the conductive pad layer 60 may form an uneven pattern 65 while being alternately arranged with respect to each other. For example, the convex portion 65a and the concave portion 65b of the conductive pad layer 60 may be alternately arranged in the third direction Z3 intersecting with the first direction Z1 in which the electrodes 11 and 12 of the battery cell 10 extend.

[0047] The conductive pad layer 60 may be formed by selectively etching a plating layer formed on the circuit portion C. For example, a conductive pad layer 60 in which a convex portion 65a, which is not etched in a depth direction (i.e., the second direction Z2) of the plating layer, and a concave portion 65b, which is etched in the depth direction, are alternately arranged, may be formed. In an embodiment of the disclosure, the convex portion 65a and the concave portion 65b, which form the conductive pad layer 60, may be formed by selectively etching a plating layer including a metal material, and may include the same metal material. For example, the convex portion 65a and the concave portion 65b may include the same metal material to have substantially the same conductivity.

[0048] The convex portion 65a and the concave portion 65b may be alternately arranged in the third direction Z3 to form the uneven pattern 65, and the uneven pattern 65 may include a plurality of convex portions 65a and a plurality of concave portions 65b, which are arranged in the third direction Z3. In an embodiment of the disclosure, the convex portion 65a may include a plurality of convex portions 65a spaced apart from each other with the concave portion 65b therebetween. Each of the convex portions 65a and the concave portions 65b, arranged in plurality in the third direction Z3, may extend in the first direction Z1, and the convex portions 65a and the concave portions 65b may extend in parallel in the first direction Z1.

[0049] Referring to FIGS. 5 to 7, the conductive pad layer 60 may include a base portion 60a surrounding the uneven pattern 65 in which the plurality of convex portions 65a and the plurality of concave portions 65b are formed. For example, the base portion 60a may form edge portions 60F, 60S, and 60R of the conductive pad layer 60. That is, the base portion 60a may form a front edge portion 60F formed at a front position relatively close to the battery cell 10 so as to face the battery cell 10 in the first direction Z1, a rear edge portion 60R formed at a rear position relatively far from the battery cell 10, and a side edge portion 60S connecting the front edge portion 60F to the rear edge portion 60R. For example, in an embodiment of the disclosure, the conductive pad layer 60 may include a first conductive pad layer 61 and a second conductive pad layer 62, which are spaced apart from each other. The edge portions 60F, 60S, and 60R of the conductive pad layer 60 may include edge portions 60F, 60S, and 60R of each of the first and second conductive pad layers 61 and 62. For example, the side edge portion 60S may include a side edge portion 60S of each of the first and second conductive pad layers 61 and 62. The base portion 60a may form the edge portions 60F, 60S, and 60R of the conductive pad layer 60 and entirely surround the uneven pattern 65 formed in an inner region of the conductive pad layer 60, and may separately surround the uneven pattern 65 of each of the first and second conductive pad layers 61 and 62.

[0050] In an embodiment of the disclosure, the uneven pattern 65 may correspond to a portion of the conductive pad layer 60, which forms physical contact with the electrodes 11 and 12 of the battery cell 10. To this end, the uneven pattern 65 may be formed at a position biased toward a front position of the conductive pad layer 60 relatively close to the battery cell 10 in the first direction Z1, and thus, the rear edge portion 60R extending long in the first direction Z1 and having a flat plate shape may be formed at a rear position of the conductive pad layer 60 that is relatively far from the battery cell 10. As will be described later, around the uneven pattern 65 and around the conductive thermocompression bonding layer 50, a step P may be formed so that the upper surface of the conductive pad layer 60 protrudes more prominently than the upper surface of the insulating layer 80 surrounding the conductive pad layer 60. The step P may be formed in the front edge portion 60F facing the battery cell 10 and a front portion of the side edge portion 60S overlapping the uneven pattern 65 or the conductive thermocompression bonding layer 50 in the third direction Z3. Technical details regarding the step P between the conductive pad layer 60 and the insulating layer 80 will be described later in more detail.

[0051] The base portion 60a may protect the uneven pattern 65 while surrounding the uneven pattern 65, and may support the uneven pattern 65. For example, the base portion 60a may be formed at the same level as the convex portion 65a of the uneven pattern 65 in the second direction Z2, and may support a plurality of convex portions 65a while extending across one end and the other end of each of the plurality of convex portions 65a in the third direction Z3. More specifically, the base portion 60a or the edge portions 60F, 60S, and 60R may entirely surround the uneven pattern 65 while extending in the first and third directions Z1 and Z3 to surround the uneven pattern 65.

[0052] In an embodiment of the disclosure, the conductive pad layer 60 may be formed by selectively etching a plating layer formed on the circuit portion C, and in this case, a non-etched portion may form the base portion 60a and the convex portion 65a and a selectively etched portion may form the concave portion 65b. In an embodiment of the disclosure, the conductive pad layer 60 may include the same metal material as a whole, and the base portion 60a, the convex portion 65a, and the concave portion 65b, which form the conductive pad layer 60, may all include the same metal material. In an embodiment of the disclosure, the metal material may be a metal material having excellent conductivity, and may include, for example, aluminum or nickel. In various embodiments of the disclosure, the conductive pad layer 60 may include two or more different metal materials, for example, first and second metal materials stacked on each other. Even in this case, because the base portion 60a, the convex portion 65a, and the concave portion 65b, which form the conductive pad layer 60, all include first and second metal materials stacked on each other, it may be said that the base portion 60a, the convex portion 65a, and the concave portion 65b include the same metal material.

[0053] As will be described later, the convex portion 65a may be connected to the electrodes 11 and 12 of the battery cell 10 through the conductive particles 51 (refer to FIG. 4) of the conductive thermocompression bonding layer 50. In addition, the convex portion 65a and the base portion 60a connected to the convex portion 65a may be connected to the circuit portion C, and the conductive pad layer 60 including the convex portion 65a and the base portion 60a may form the charge and discharge path of the battery cell 10 between the battery cell 10 and the circuit portion C. That is, the base portion 60a may provide a low-resistance charge and discharge path having a larger area than the convex portion 65a.

[0054] In an embodiment of the disclosure, the electrodes 11 and 12 of the battery cell 10 may be connected to the circuit portion C through the convex portion 65a and the base portion 60a, and the concave portion 65b including the same metal material as the convex portion 65a and the base portion 60a may also form a charge and discharge path through which the charge and discharge current of the battery cell 10 flows. However, as will be described later, the concave portion 65b may provide an accommodation space for accommodating the insulating resin 52 rather than being directly connected to the electrodes 11 and 12 of the battery cell 10 through the conductive particles 51 (refer to FIG. 4).

[0055] Throughout the present specification, that the conductive particles 51 (refer to FIG. 4) of the conductive thermocompression bonding layer 50 are connected to the electrodes 11 and 12 of the battery cell 10 does not mean that the formation of the charge and discharge path of the battery cell 10 is limited to the convex portion 65a providing a support base for the conductive particles 51 and the base portion 60a connected to the convex portion 65a. For example, in various embodiments of the disclosure, the charge and discharge path of the battery cell 10 may be formed through the entire conductive pad layer 60 including the uneven pattern 65 and the base portion 60a, the uneven pattern 65 including the convex portion 65a and the concave portion 65b. Similarly, in the present specification, that the battery cell 10 and the circuit portion C are connected to each other through the conductive particles 51 (refer to FIG. 4) arranged on the convex portion 65a does not mean that the charge and discharge path of the battery cell 10 is limited to the convex portion 65a, and the charge and discharge path of the battery cell 10 may be formed through part of the conductive pad layer 60 including the convex portion 65a or all of the conductive pad layer 60.

[0056] Referring to FIG. 4, the conductive pad layer 60 may be configured such that conductive transition of the conductive thermocompression bonding layer 50 that forms the connection portion 56 together with the conductive pad layer 60 may be smoothly performed. The convex portion 65a forming the uneven pattern 65 of the conductive pad layer 60 may provide a support base for the conductive particles 51 of the conductive thermocompression bonding layer 50, and the concave portion 65b may provide a concave accommodation space capable of accommodating the insulating resin 52 of the conductive thermocompression bonding layer 50. For example, when the conductive thermocompression bonding layer 50 is heated above the transition temperature, the insulating resin 52 of the conductive thermocompression bonding layer 50 has fluidity. In this case, the insulating resin 52 having fluidity may be accommodated in the concave accommodation space, provided by the concave portion 65b, while being pushed from the convex portion 65a into the concave portion 65b according to a pressure applied between the electrodes 11 and 12 of the battery cell 10 and the circuit portion C, that is, a pressure applied in the second direction Z2 to make the electrodes 11 and 12 of the battery cell 10 and the circuit portion C approach each other, and the conductive particles 51 remaining on the convex portion 65a may electrically connect the electrodes 11 and 12 of the battery cell 10 to the circuit portion C.

[0057] More specifically, the concave portion 65b may provide an accommodation space for accommodating the insulating resin 52 of the conductive thermocompression bonding layer 50, and may provide an accommodation space having sufficient volume to accommodate the insulating resin 52 so that the insulating resin 52 pushed into the accommodation space of the insulating resin 52 does not interfere with a conductive contact between the conductive particles 51 remaining on the convex portion 65a and the battery cell 10.

[0058] In a comparative example to be contrasted with the disclosure, a conductive pad layer 60 on a flat plate not provided with the uneven pattern 65 may be connected to the electrodes 11 and 12 of the battery cell 10. In this case, because the conductive pad layer 60 on the flat plate does not provide a differentiated support base for each component of the conductive thermocompression bonding layer 50, the insulating resin 52 and the conductive particles 51, which form the conductive thermocompression bonding layer 50, may be mixed and the insulating resin 52 may interfere with the contact of the conductive particles 51 to the electrodes 11 and 12 of the battery cell 10. As a result, this may result in an increase in electrical resistance between the electrodes 11 and 12 of the battery cell 10 and the conductive pad layer 60.

[0059] In an embodiment of the disclosure, because the conductive pad layer 60 is connected to the electrodes 11 and 12 of the battery cell 10 through the uneven pattern 65 formed on the conductive pad layer 60, a differentiated support base may be provided for each component of the conductive thermocompression bonding layer 50, that is, the conductive particles 51 and the insulating resin 52, through the uneven pattern 65 of the conductive pad layer 60. More specifically, the conductive pad layer 60 may support the conductive particles 51 through the convex portions 65a of the uneven pattern 65, and thus, an electrical connection between the conductive particles 51 remaining on the convex portion 65a and the electrodes 11 and 12 of the battery cell 10 may be made. In addition, as the insulating resin 52 is accommodated through the concave portion 65b of the uneven pattern 65, the insulating resin 52 may not interfere with the contact between the conductive particles 51 remaining and placed on the convex portion 65a and the electrodes 11 and 12 of the battery cell 10.

[0060] Referring to FIG. 3, in the battery cell 10 according to an embodiment of the disclosure, the first and second electrodes 11 and 12 having different polarities may be arranged in the third direction Z3 intersecting with the first direction Z1 in which the first and second electrodes 11 and 12 extend. The first and second electrodes 11 and 12 may be respectively connected to the first and second conductive pad layers 61 and 62 provided separately. That is, in an embodiment of the disclosure, the conductive pad layer 60 may include the first and second conductive pad layers 61 and 62 that are apart from each other in the third direction Z3 and are respectively connected to the first and second electrodes 11 and 12 that are different from each other. In an embodiment of the disclosure, the first and second conductive pad layers 61 and 62 may be electrically connected to the first and second electrodes 11 and 12 of the battery cell 10 through one conductive thermocompression bonding layer 50 continuously extending across the first and second conductive pad layers 61 and 62 in the third direction Z3.

[0061] In an embodiment of the disclosure, the conductive thermocompression bonding layer 50 may have conductivity in the second direction Z2, and may electrically connect the first and second electrodes 11 and 12 of the battery cell 10 to the first and second conductive pad layers 61 and 62, the first and second electrodes 11 and 12 and the first and second conductive pad layers 61 and 62 being arranged to overlap each other in the second direction Z2 with the conductive thermocompression bonding layer 50 therebetween. However, the conductive thermocompression bonding layer 50 may have no conductivity in the third direction Z3, and thus may not cause an electrical short circuit between the first and second electrodes 11 and 12 of the battery cell 10 or between the first and second conductive pad layers 61 and 62. In an embodiment of the disclosure, the conductive thermocompression bonding layer 50 may have anisotropy, in which conductive properties change depending on the direction, so that the conductive thermocompression bonding layer 50 has conductivity in the second direction Z2 and non-conductivity (or insulation) in the third direction Z3. As described above, in an embodiment of the disclosure, the first and second conductive pad layers 61 and 62 respectively connected to the first and second electrodes 11 and 12 having different polarities may be provided to be separated from each other, but the conductive thermocompression bonding layer 50 connecting the first electrode 11 to the first conductive pad layer 61 and connecting the second electrode 12 to the second conductive pad layer 62 may be provided as a single member continuously formed. Thus, the connection between the first and second electrodes 11 and 12 and the first and second conductive pad layers 61 and 62 may be collectively formed through one operation. In addition, the first and second electrodes 11 and 12 may be electrically connected to the first and second conductive pad layer 61 and 62, respectively, in the second direction Z2 by using the conductive thermocompression bonding layer 50 having anisotropy, which has different conductive properties depending on the direction, and an electrical short circuit between the first and second electrodes 11 and 12 and between the first and second conductive pad layers 61 and 62 in the third direction Z3 may also be prevented.

[0062] Referring to FIGS. 3 and 4, the conductive thermocompression bonding layer 50 according to an embodiment of the disclosure may have conductivity according to thermocompression bonding. In this case, the conductive thermocompression bonding layer 50 may have conductivity according to a compression direction (corresponding to the second direction Z2) and may have non-conductivity (or insulation) in a direction different from the compression direction, for example, in a direction perpendicular to the compression direction. For example, in an embodiment of the disclosure, the conductive thermocompression bonding layer 50 may connect the electrodes 11 and 12 of the battery cell 10 to the conductive pad layer 60 while being compressed in the second direction Z2 corresponding to the compression direction. The conductive thermocompression bonding layer 50 may include a plurality of conductive particles 51 dispersed on the insulating resin 52. In addition, while the insulating resin 52 having fluidity according to heating is pushed in the second direction Z2 corresponding to the compression direction, the remaining conductive particles 51 may connect the electrodes 11 and 12 of the battery cell 10 to the conductive pad layer 60, the electrodes 11 and 12 and the conductive pad layer 60 overlapping each other in the second direction. However, in the third direction Z3 that does not correspond to the compression direction, electrical connection through the conductive particles 51 may be blocked as a plurality of conductive particles 51 are discontinuously arranged or the insulating resin 52 fills gaps between the plurality of conductive particles 51. In a specific embodiment of the disclosure, the conductive thermocompression bonding layer 50 may include an anisotropic conductive film (ACF).

[0063] Referring to FIGS. 5 to 7, an insulating layer 80 surrounding the conductive pad layer 60 may be formed around the conductive pad layer 60. The insulating layer 80 may provide insulation with respect to the conductive pad layer 60. For example, the insulating layer 80 may provide electrical insulation between the conductive pad layer 60 and another conductive line of the circuit portion C. In various embodiments of the disclosure, the circuit portion C may include another conductive line insulated from a conductive line conducting electricity with the conductive pad layer 60, and in this case, the insulating layer 80 may provide electrical insulation between the conductive pad layer 60 and the other conductive line.

[0064] The conductive pad layer 60 may be surrounded by the insulating layer 80. Throughout the present specification, that the conductive pad layer 60 is surrounded by the insulating layer 80 may mean that, as the conductive pad layer

60 is formed on the insulating layer 80 in the second direction Z2, the conductive pad layer 60 formed with a relatively narrow area is formed on the insulating layer 80 formed with a relatively large area. In an embodiment of the disclosure, the conductive pad layer 60 may be formed in an inner region of the insulating layer 80 on a plane formed by the first and third directions Z1 and Z3, and the thickness of the conductive pad layer 60 in the second direction Z2 may be exposed from the insulating layer 80. That is, throughout the present specification, that the conductive pad layer 60 is surrounded by the insulating layer 80 may mean that the conductive pad layer 60 is formed in the inner region of the insulating layer 80 on a plane formed by the first and third directions Z1 and Z3. In this case, the conductive pad layer 60 may be formed in the inner region of the insulating layer 80 on a plane formed by the first and third directions Z1 and Z3, and the thickness of the conductive pad layer 60 may be exposed from the insulating layer 80 in the second direction Z2.

[0065] In various embodiments of the disclosure, the thickness of the conductive pad layer 60 may be surrounded by the insulating layer 80 in the second direction Z2. That is, in various embodiments of the disclosure, the conductive pad layer 60 may be formed in the inner region of the insulating layer 80 on a plane formed by the first and third directions Z1 and Z3, and at the same time, the thickness of the conductive pad layer 60 may be surrounded by the insulating layer 80 in the second direction Z2. However, as will be described later, even when the thickness of the conductive pad layer 60 is surrounded by the insulating layer 80, the thickness of the conductive pad layer 60 may be exposed around the uneven pattern 65 along the edge portions 60F, 60S, and 60R of the conductive pad layer 60. That is, the upper surface of the conductive pad layer 60 around the uneven pattern 65 may be formed at a level higher than the upper surface of the insulating layer 80, and the upper surface of the conductive pad layer 60 and the upper surface of the insulating layer 80 may be formed to be stepped in the second direction Z2. In other words, a step P, which is formed by the upper surface of the conductive pad layer 60 and the upper surface of the insulating layer 80, may be formed around the uneven pattern 65 along the edge portions 60F, 60S, and 60R of the conductive pad layer 60.

[0066] Referring to FIG. 3, in an embodiment of the disclosure, the step P between the conductive pad layer 60 and the insulating layer 80 may be formed around the uneven pattern 65 in a boundary between the conductive pad layer 60 and the insulating layer 80. In this case, the periphery of the uneven pattern 65 may include a boundary, which overlaps the uneven pattern 65 in at least the third direction Z3, in the boundary between the conductive pad layer 60 and the insulating layer 80. The step P between the conductive pad layer 60 and the insulating layer 80 may significantly protrude the upper surface of the conductive pad layer 60 rather than the upper surface of the insulating layer 80, thereby providing effective pressure concentration for the conductive thermocompression bonding layer 50 formed on the conductive pad layer 60 and preventing a pressure gap of a pressing tool TO due to physical interference with the insulating layer 80.

[0067] In the thermocompression bonding, a certain heat and pressure may be provided to the conductive thermocompression bonding layer 50 between the electrodes 11 and 12 of the battery cell 10 and the conductive pad layer 60, thereby forming a conductive connection between the electrodes 11 and 12 of the battery 10 and the conductive pad layer 60. In this case, through the pressing tool TO pressing in the second direction Z to make the electrodes 11 and 12 of the battery cell 10 and the conductive pad layer 60 approach each other, the electrodes 11 and 12 and the conductive pad layer 60 being arranged to overlap each other with the conductive thermocompression bonding layer 50 therebetween, a certain heat and pressure may be applied to the conductive thermocompression bonding layer 50. In this case, a region pressed by the pressing tool TO corresponds to a pressing region to which the pressing tool TO is projected in the second direction Z2. In the pressing region of the pressing tool TO, the conductive pad layer 60 to be pressed may remarkably protrude in the second direction Z2 rather than the insulating layer 80 surrounding the conductive pad layer 60, and thus, effective pressurization of the conductive pad layer 60 rather than the insulating layer 80 may be made, and interference or a pressure gap caused by the insulating layer 80 may be prevented.

[0068] Referring to FIGS. 5 to 7, in an embodiment of the disclosure, the step P between the upper surface of the conductive pad layer 60 and the upper surface of the insulating layer 80 may be formed around the uneven pattern 65 along the edge portions 60F, 60S, and 60R of the conductive pad layer 60, and may be formed in a side edge portion 60S of the conductive pad layer 60, which overlaps the uneven pattern in the third direction Z3. In an embodiment of the disclosure, the step P of the conductive pad layer 60 may also be formed in a front edge portion 60F, formed at a position relatively close to the battery cell 10 to face the battery cell 10 in the first direction Z1, as well as the side edge portion 60S. In this case, the front edge portion 60F of the conductive pad layer 60 may refer to an edge portion, which faces the battery cell 10, that is, is formed at a position relatively close to the battery cell 10, from among the edge portions 60F, 60S, and 60R of the conductive pad layer 60. In an embodiment of the disclosure, a rear edge portion 60R (corresponding to the thickness of the rear edge portion 60R) of the conductive pad layer 60 formed at a position relatively far from the battery cell 10 may be surrounded by the insulating layer 80 in the second direction Z2. For example, the insulating layer 80 may include a thick portion 80a formed to have a relatively large thickness to surround the rear edge portion 60R (corresponding to the thickness of the rear edge portion 60R).

[0069] In an embodiment of the disclosure, the conductive pad layer 60 may include a side edge portion 60S connecting the front edge portion 60F to the rear edge portion 60R, in addition to the front edge portion 60F and the rear edge portion 60R. In an embodiment of the disclosure, in a front portion of the front edge portion 60F and the side edge portion

60S each formed around the uneven pattern 65, a step P for remarkably protruding the upper surface of the conductive pad layer 60 may be formed, and the rear edge portion 60R (corresponding to the thickness of the rear edge portion 60R) far from the uneven pattern 65 and a rear portion of the side edge portion 60S (corresponding to the thickness of the side edge portion 60S) may be surrounded by the insulating layer 80. For example, the insulating layer 80 may include a thick portion 80a formed to have a relatively large thickness to surround the rear edge portion 60R (corresponding to the thickness of the rear edge portion 60R) and the rear portion (corresponding to the thickness of the side edge portion 60S) of the side edge portion 60S. In an embodiment of the disclosure, the thick portion 80a of the insulating layer 80 may provide insulation of the conductive pad layer 60 by surrounding the rear edge portion 60R (corresponding to the thickness of the rear edge portion 60R) and the rear portion (corresponding to the thickness of the side edge portion 60S) of the side edge portion 60S.

[0070] In an embodiment of the disclosure, the step P between the conductive pad layer 60 and the insulating layer 80 may be formed around the uneven pattern 65. In various embodiments of the disclosure, the step P between the conductive pad layer 60 and the insulating layer 80 may be formed around the pressing region rather than around the uneven pattern 65. That is, because the step P is to provide effective pressurization to the conductive thermocompression bonding layer 50, formed on the conductive pad layer 60, by significantly protruding the conductive pad layer 60 rather than the insulating layer 80, the step P may be formed around the pressing region, which corresponds to a projection region of the pressing tool TO (refer to FIG. 3), in the conductive pad layer 60.

[0071] For example, the pressing region of the conductive pad layer 60 may correspond to a projection region on which the pressing tool TO is projected in the second direction Z2 and may correspond to a projection region on which the conductive thermocompression bonding layer 50 to be pressed is projected. In an embodiment of the disclosure, the pressing region may refer to a portion of the uneven pattern 65 overlapping the conductive thermocompression bonding layer 50 and may refer to a portion of the uneven pattern 65 overlapping the conductive thermocompression bonding layer 50 in the first direction Z1, rather than the entirety of the uneven pattern 65, and a step P for effective pressurization of the conductive thermocompression bonding layer 50 may be formed around a portion of the uneven pattern 65 overlapping the conductive thermocompression bonding layer 50. For example, the step P may be formed in a side edge portion 60S of the conductive pad layer 60 overlapping the conductive thermocompression bonding layer 50 in the third direction Z3, rather than being formed in a side edge portion 60S of the conductive pad layer 60 overlapping the entirety of the uneven pattern 65 in the third direction Z3.

[0072] The pressing region may extend in the third direction Z3 in which the first and second electrodes 11 and 12 are arranged, and by applying the pressing tool TO (refer to FIG. 3) along a pressing region extending across the first and second electrodes 11 and 12, a sufficient pressure may be applied to the conductive thermocompression bonding layer 50 between the first and second electrodes 11 and 12 and the first and second conductive pad layers 61 and 62. In this case, the pression tool TO may press the conductive thermocompression bonding layer 50 between the first and second electrodes 11 and 12 and the first and second conductive pad layers 61 and 62 at a time through one pressurization to the pressing region. In various embodiments of the disclosure, the pressing tool TO may press the conductive thermocompression bonding layer 50 between the first and second electrodes 11 and 12 and the first and second conductive pad layers 61 and 62 at different times through divided pressurization to the pressing region. The pressing tool TO may include a heater therein and may provide sufficient heat for connection between the electrode 11 and 12 of the battery cell 10 and the conductive pad layer 60, in addition to pressurization to the conductive thermocompression bonding layer 50.

[0073] In an embodiment of the disclosure, the conductive pad layer 60 may be formed on the circuit portion C, and the insulating layer 80 may be formed as a portion of the circuit portion C. Through the present specification, the conductive pad layer 60 may be formed on the circuit portion C, and even though the insulating layer 80 is formed as a portion of the circuit portion C, the conductive pad layer 60 and the insulating layer 80 may be formed integrally with the circuit portion C. In an embodiment of the disclosure, the circuit portion C may be formed to have a multilayer structure in which the insulating layer 80 is formed between a plurality of conductive lines, and the conductive pad layer 60 may be formed on the circuit portion C including the insulating layer 80 as one component. For example, a plating layer may be formed on the insulating layer 80 of the circuit portion C, and the conductive pad layer 60 having the uneven pattern 65 formed thereon may be formed by selectively etching the plating layer.

[0074] FIGS. 8A and 8B illustrate the structures of a comparative example and an embodiment of the disclosure for measuring a connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60, as an experiment for showing the technical effects of an embodiment of the disclosure. Referring to FIGS. 8A and 8B, in the experiment for showing the technical effects of an embodiment of the disclosure, by measuring the value of a connection resistance between the electrode 11 of the battery cell 10 and the conductive pad layer 60 on the charge and discharge path of the battery cell 10 from the electrode 11 of the battery cell 10 to the conductive pad layer 60, connection resistance values measured on the charge and discharge path of the battery cell 10 are compared, and through the comparison of the connection resistance values in the comparative example and the embodiment of the disclosure, the technical effects of the embodiment of the disclosure are shown in that the connection resistance value on the charge and discharge path is reduced in the embodiment of the disclosure compared to the comparative example. In this case, the connection resistance value may refer to a resistance between the electrode 11 of the battery cell 10 and the conductive pad layer 60, the resistance being formed by the conductive thermocompression bonding layer 50.

[0075] More specifically, in this experiment, after the self-resistance value of each of the electrode 11 of the battery cell 10 and the conductive pad layer 60 is measured, a connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 may be calculated by subtracting previously measured self-resistance values of the electrode 11 of the battery cell 10 and the conductive pad layer 60 from a resistance value on the entire charge and discharge path between the electrode 11 of the battery cell 10 and the conductive pad layer 60. In this experiment, the connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 may be calculated by subtracting self-resistance values of the electrode 11 of the battery cell 10 and the conductive pad layer 60 from a resistance value measured on the entire charge and discharge path. For example, in this experiment, three measurement points EP1, EP2, and MP are set on the charge and discharge path of the battery cell 10, which is formed between the electrode 11 of the battery cell 10 and the conductive pad layer 60, and a middle measurement point MP is set at an intermediate position between the electrode 11 of the battery cell 10 and the conductive pad layer 60 where two end measurement points EP1 and EP2 corresponding to end positions on the charge and discharge path are set. In this case, the middle measurement point MP may correspond to a connection position between the electrode 11 of the battery cell 10 and the conductive pad layer 60. Accordingly, three measuring points EP1, EP2, and MP including two end measurement points EP1 and EP2 and one middle measurement point MP may be set, a resistance value from the end measurement point EP1, set on the electrode 11 of the battery cell 10, to the middle measurement point MP may correspond to the self-resistance value of the electrode 11 of the battery cell 10, a resistance value from the end measurement point EP2, set on the conductive pad layer 60, to the middle measurement point MP may correspond to the self-resistance value of the conductive pad layer 60, and a resistance value between the end measurement point EP1 and the end measurement point EP2 may correspond to a resistance value on the entire charge and discharge path. In this case, the resistance value on the entire charge and discharge path may refer to a resistance value measured in a connection state between the electrode 11 of the battery cell 10 and the conductive pad layer 60. In this experiment, a connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 may be calculated by previously measuring self-resistance values of the electrode 11 of the battery cell 10 and the conductive pad layer 60 and then subtracting the previously measured self-resistance values of the electrode 11 of the battery cell 10 and the conductive pad layer 60 from a resistance value on the entire charge and discharge path between the electrode 11 of the battery cell 10 and the conductive pad layer 60. As such, in the embodiment of the disclosure, because the connection resistance value between the battery cell 10 and the conductive pad layer 60 is calculated in an indirect method of subtracting the self-resistance values of the electrode 11 of the battery cell 10 and the conductive pad layer 60 from a resistance value on the entire charge and discharge path, rather than a direct measurement method, the connection resistance value may be obtained as a minus (-) value after a decimal point, as will be described later, and the minus (-) value may correspond to an experimental measurement error. That is, as in the experimental results of the disclosure, a minus (-) value after a decimal point may mean that the connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 may be reduced to a level close to zero.

[0076] Tables 1 and 2 below show experimental results showing resistance values measured in a comparative example and an embodiment of the disclosure, respectively, when the electrode 11 of the battery cell 10 is formed of a nickel material. The number of experiments performed in the comparative example is different form that performed in the embodiment of the disclosure, and when comparing the connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 in the comparative example to the connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 in the embodiment of the disclosure, it may be seen that the connection resistance value in the embodiment of the disclosure is remarkably reduced. That is, in a case in which the conductive thermocompression bonding layer 50 mediating the connection between the electrode 11 of the battery cell 10 and the conductive pad layer 60 is formed on the uneven pattern 65 on the conductive pad layer 60, as in the embodiment of the disclosure, compared to a case in which the conductive thermocompression bonding layer 50 mediating the connection between the electrode 11 of the battery cell 10 and the conductive pad layer 60 is formed on the base portion 60a of the conductive pad layer 60 in which the uneven pattern 65 is not formed, as in the comparative example, it may be seen that the connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 is significantly reduced.

[Table 1]

No (unit: mΩ)	conductive pad layer	electrode of battery cell	resistance on entire charge and discharge path	connection resistance
1	1.47	5.07	8.67	2.13

(continued)

No (unit: mΩ)	conductive pad layer	electrode of battery cell	resistance on entire charge and discharge path	connection resistance
2	1.53	4.97	8.17	1.67
3	1.61	5.13	17.65	10.91

[Table 2]

No	conductive pad layer	electrode of battery cell	resistance on entire charge and discharge path	connection resistance
1	1.89	4.84	6.03	-0.7
2	1.87	5.30	6.24	-0.93
3	1.84	4.58	6.04	-0.38
4	1.90	4.85	6.50	-0.25
5	1.94	4.79	5.83	-0.90
6	1.80	4.83	6.20	-0.43
7	1.97	4.61	6.15	-0.43
8	1.87	4.25	5.62	-0.50
9	1.86	4.47	6.10	-0.23
10	1.77	4.63	6.08	-0.32

[0077] Tables 3 and 4 below show experimental results showing resistance values measured in a comparative example and an embodiment of the disclosure, respectively, when the electrode 11 of the battery cell 10 is formed of an aluminum material. The number of experiments performed in the comparative example is different form that performed in the embodiment of the disclosure, and when comparing the connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 in the comparative example to the connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 in the embodiment of the disclosure, it may be seen that the connection resistance value in the embodiment of the disclosure is remarkably reduced. As described above, in a case in which the conductive thermocompression bonding layer 50 is formed on the uneven pattern 65 on the conductive pad layer 60, as in the embodiment of the disclosure, compared to a case in which the conductive thermocompression bonding layer 50 is formed on the base portion 60a of the conductive pad layer 60 in which the uneven pattern 65 is not formed, as in the comparative example, it may be seen that the connection resistance value between the electrode 11 of the battery cell 10 and the conductive pad layer 60 is significantly reduced.

[Table 3]

No (unit: mΩ)	conductive pad layer	electrode of battery cell	resistance on entire charge and discharge path	connection resistance
4	1.51	1.63	8.22	5.08
5	1.57	1.58	89.20	86.05
6	1.52	1.44	9.80	6.84

[Table 4]

No (unit: mΩ)	conductive pad layer	electrode of battery cell	resistance on entire charge and discharge path	connection resistance
11	2.06	1.69	2.93	-0.82

(continued)

No (unit: mΩ)	conductive pad layer	electrode of battery cell	resistance on entire charge and discharge path	connection resistance
12	2.06	1.63	2.82	-0.87
13	1.99	1.49	2.89	-0.59
14	2.03	1.49	2.92	-0.60
15	2.10	1.60	2.91	-0.79
16	2.11	1.40	2.71	-0.80
17	1.93	1.42	2.90	-0.45
18	1.94	1.53	2.89	-0.58
19	1.95	1.55	2.85	-0.65
20	2.03	1.48	2.85	-0.66

[0078] According to the disclosure, a battery pack in which a connection process may be easily performed while increasing reliability of an electrical connection between a battery cell and a circuit portion forming a charge and discharge path of the battery cell may be provided.

[0079] It should be understood that embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each embodiment should typically be considered as available for other similar features or aspects in other embodiments. While one or more embodiments have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the scope of the disclosure as defined by the following claims.

Claims

1. A battery pack comprising:

a battery cell (10) including an electrode (11, 12) extending in a first direction;
a circuit portion (C) connected to the electrode (11, 12) of the battery cell (10); and
a connection portion (56) forming a connection between the electrode (11, 12) of the battery cell (10) and the circuit portion (C), the connection portion (56) including a conductive thermocompression bonding layer (50) and a conductive pad layer (60) having a concave accommodation space formed in a second direction intersecting with the first direction to accommodate a portion of the conductive thermocompression bonding layer (50).

2. The battery pack of claim 1, wherein the electrode includes a first electrode and a second electrode, arranged in a third direction intersecting with the first and second directions, the first and second electrodes having different polarities,
wherein the conductive pad layer includes a first conductive pad layer and a second conductive pad layer, which are spaced apart from each other in the third direction so as to be connected to the first electrode and the second electrode, respectively.

3. The battery pack of claim 2, wherein the conductive thermocompression bonding layer is continuously formed in the third direction between the first electrode and the first conductive pad layer and between the second electrode and the second conductive pad layer.

4. The battery pack of any preceding claim, wherein the conductive thermocompression bonding layer is between the electrode of the battery cell and the conductive pad layer in the second direction.

5. The battery pack of any preceding claim, wherein the conductive pad layer includes a convex portion relatively protruding in the second direction and a concave portion relatively concave in the second direction.

6. The battery pack of claim 5, wherein the concave portion provides the concave accommodation space.

7. The battery pack of claim 5 or 6, wherein the conductive thermocompression bonding layer includes conductive particles supported on the convex portion and an insulating resin accommodated in the concave portion;

and/or wherein the convex portion and the concave portion extend in parallel in the first direction;
and/or wherein the convex portion and the concave portion include a same metal material.

8. The battery pack of claim 5, 6 or 7, wherein the conductive pad layer includes
an uneven pattern in which the convex portion and the concave portion are alternately arranged in a third direction intersecting with the first and second directions.

9. The battery pack of claim 8, wherein the uneven pattern is formed at a position biased close to a front position of the conductive pad layer facing the battery cell;
and/or wherein the uneven pattern is completely surrounded by an edge portion of the conductive pad layer.

10. The battery pack of any preceding claim, wherein an insulating layer is formed around the conductive pad layer.

11. The battery pack of claim 10, wherein at least some edge portions of the conductive pad layer forming a boundary between the conductive pad layer and the insulating layer form a step so that an upper surface of the conductive pad layer protrudes more prominently than an upper surface of the insulating layer in the second direction.

12. The battery pack of claim 11, wherein the step is formed around an uneven pattern formed on the conductive pad layer.

13. The battery pack of claim 11, wherein the step is formed around the conductive thermocompression bonding layer.

14. The battery pack of claim 11, 12 or 13, wherein the edge portions of the conductive pad layer include:

a front edge portion formed at a position relatively close to the battery cell in the first direction;
a rear edge portion formed at a position relatively far from the battery cell in the first direction; and
a side edge portion connecting the front edge portion to the rear edge portion.

15. The battery pack of claim 14, wherein the step is formed in a front portion of the side edge portion overlapping the uneven pattern in a third direction intersecting with the first and second directions;

and/or wherein the step is formed in a front portion of the side edge portion overlapping the conductive thermocompression bonding layer in a third direction intersecting with the first and second directions;
and/or wherein the step is formed in the front edge portion relatively close to the battery cell in the first direction.

FIG. 1

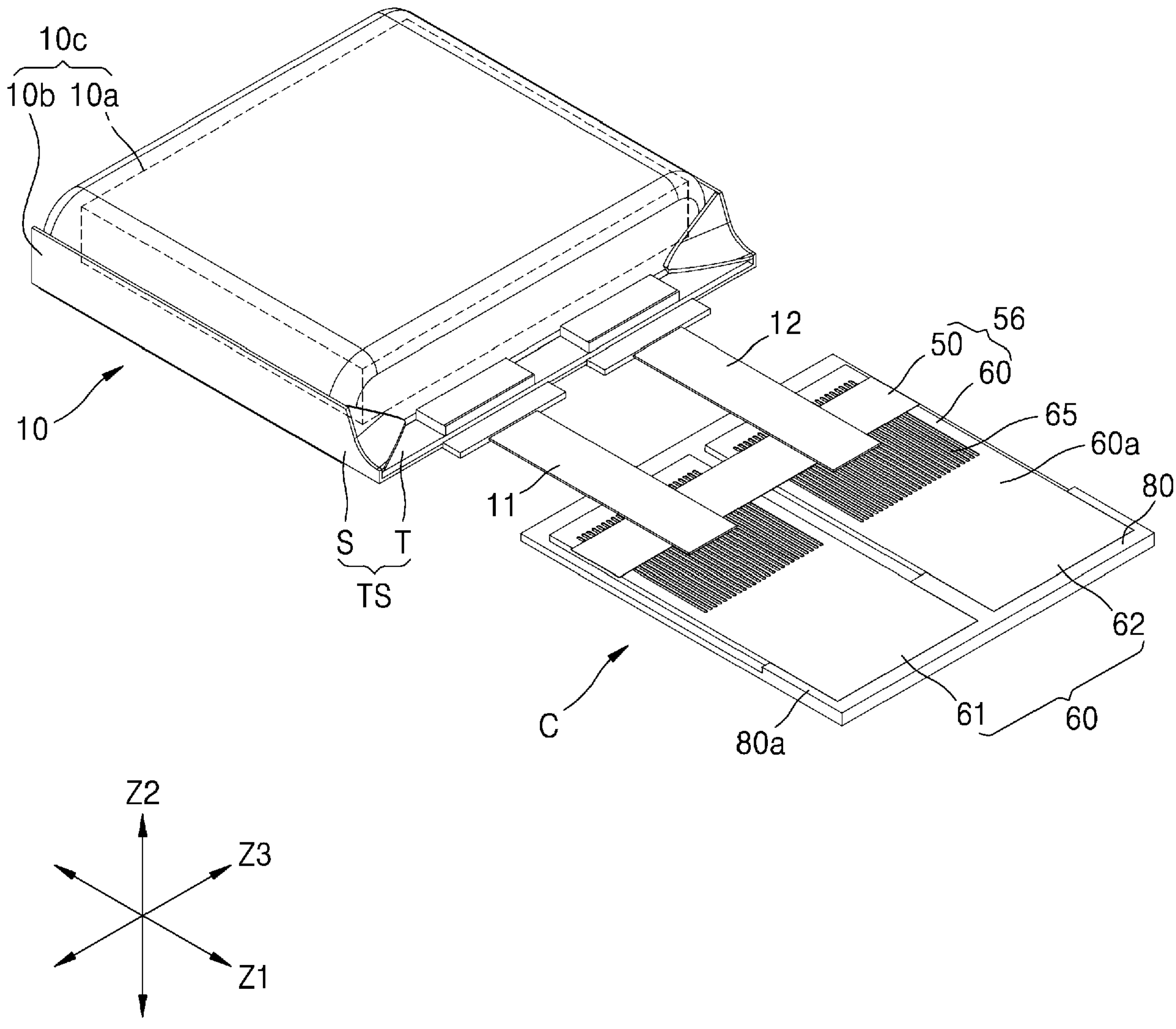

FIG. 2

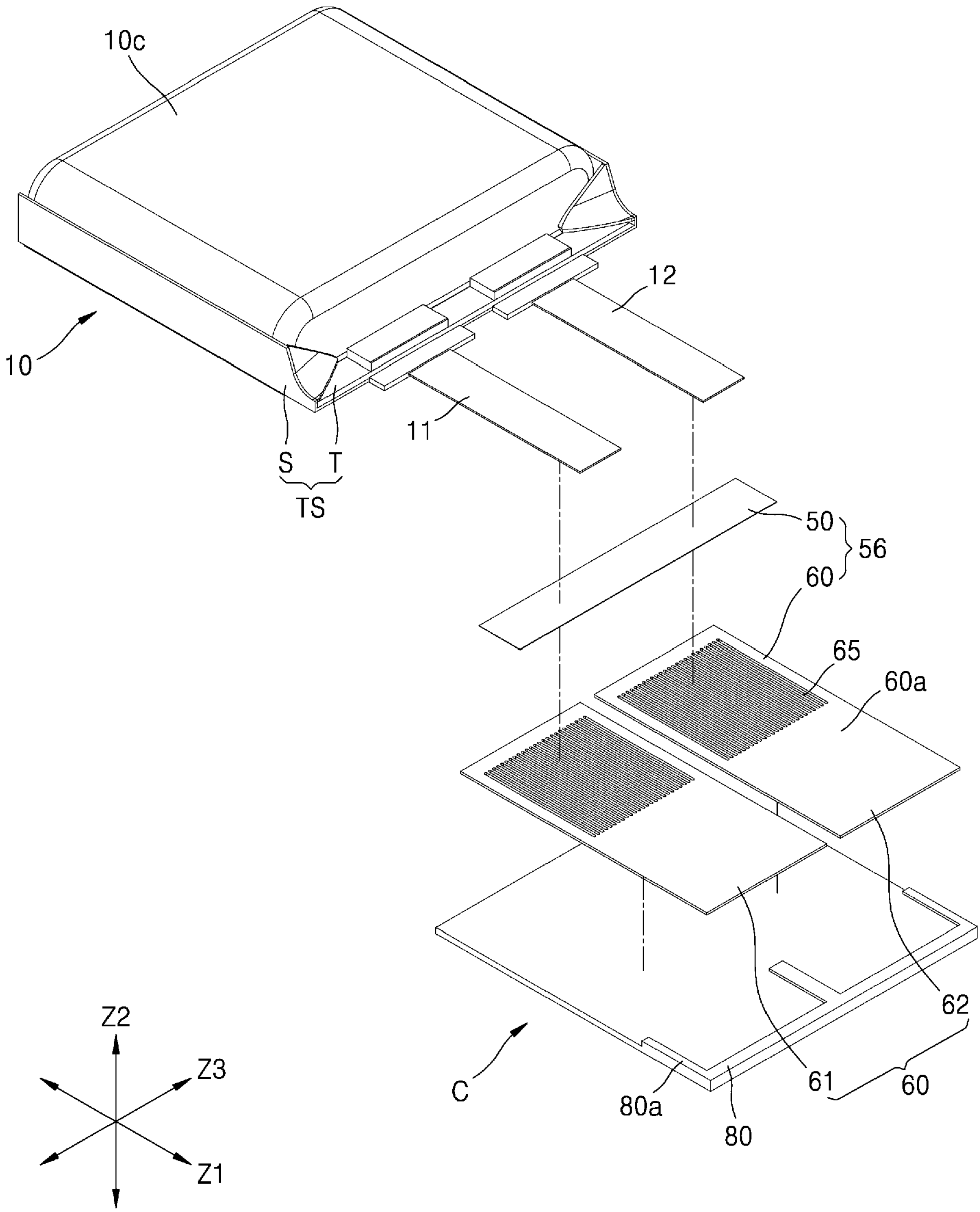

FIG. 3

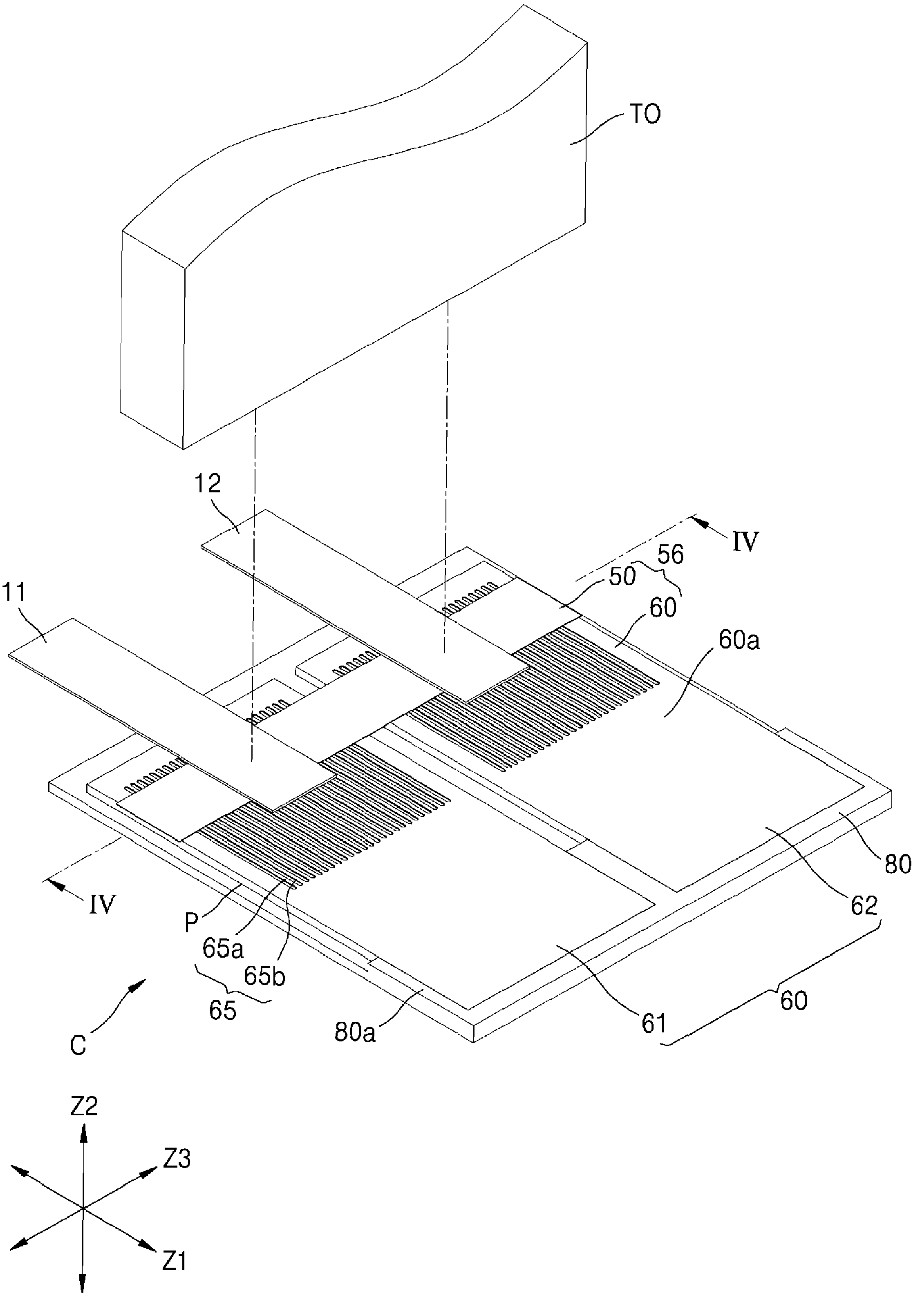

FIG. 4

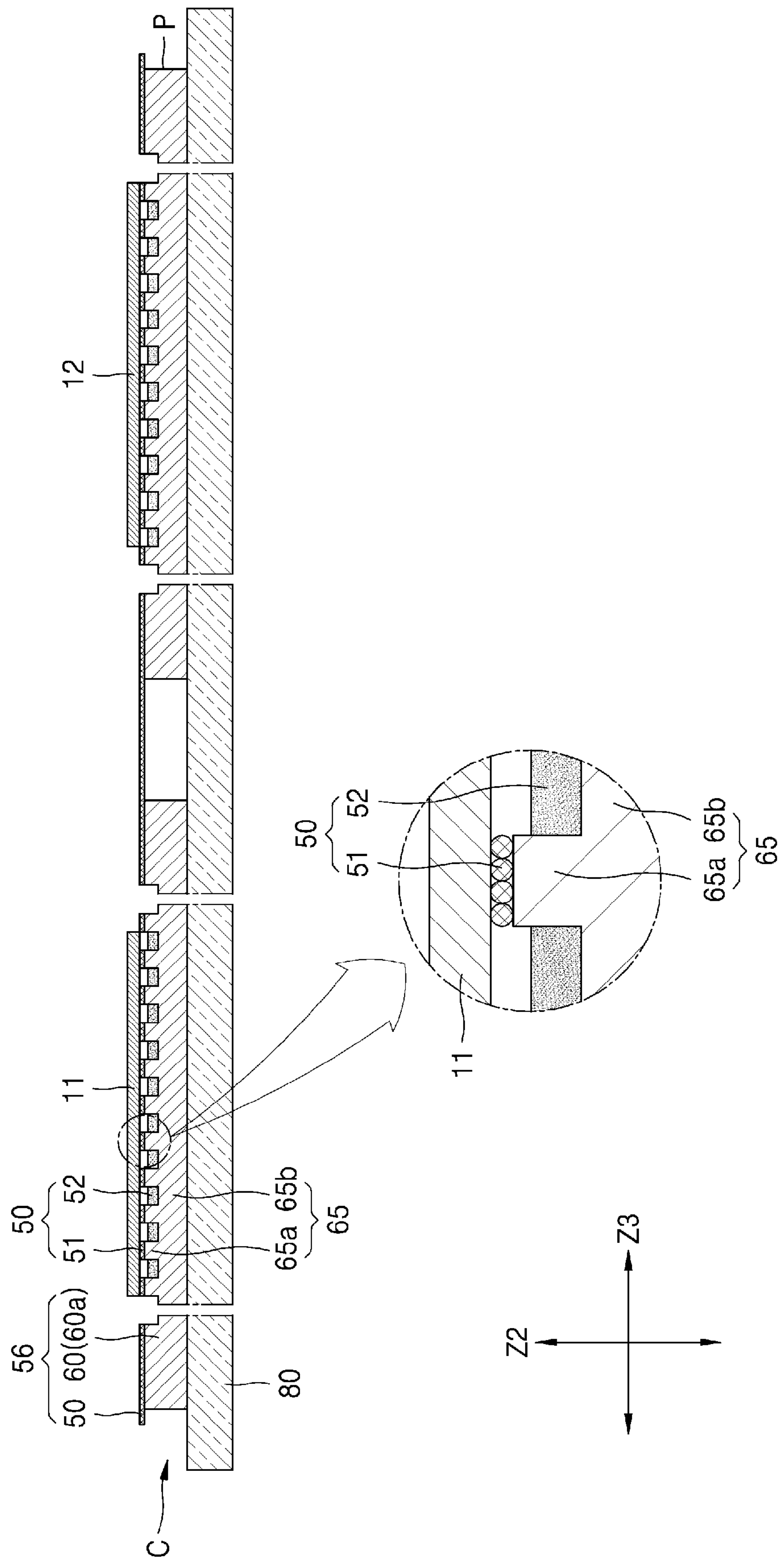
P
12
11
50
52
51
65a
65b
65
56
60(60a)
50
80
C
50
52
51
65a
65b
65
11
Z2
Z3

FIG. 5

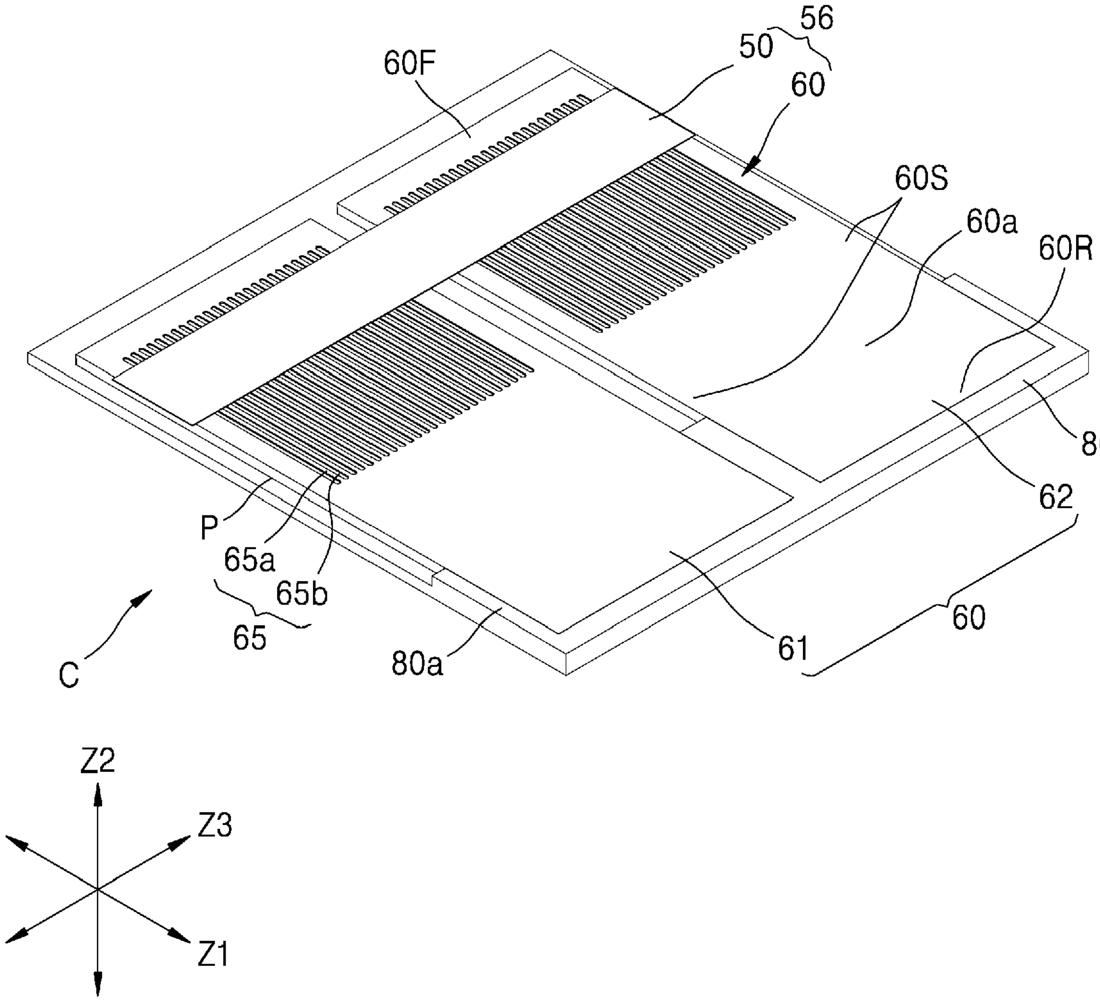

FIG. 6

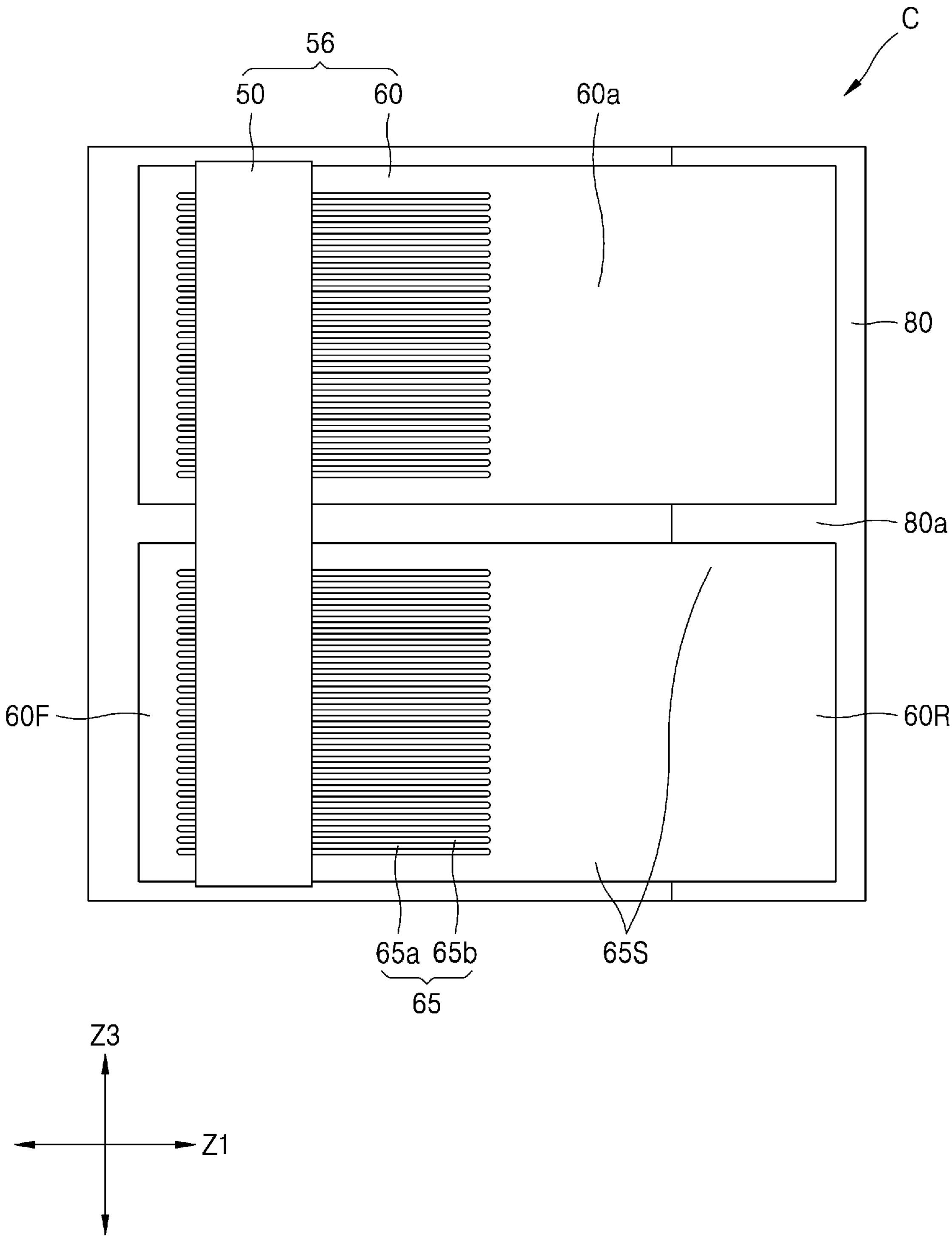

FIG. 7

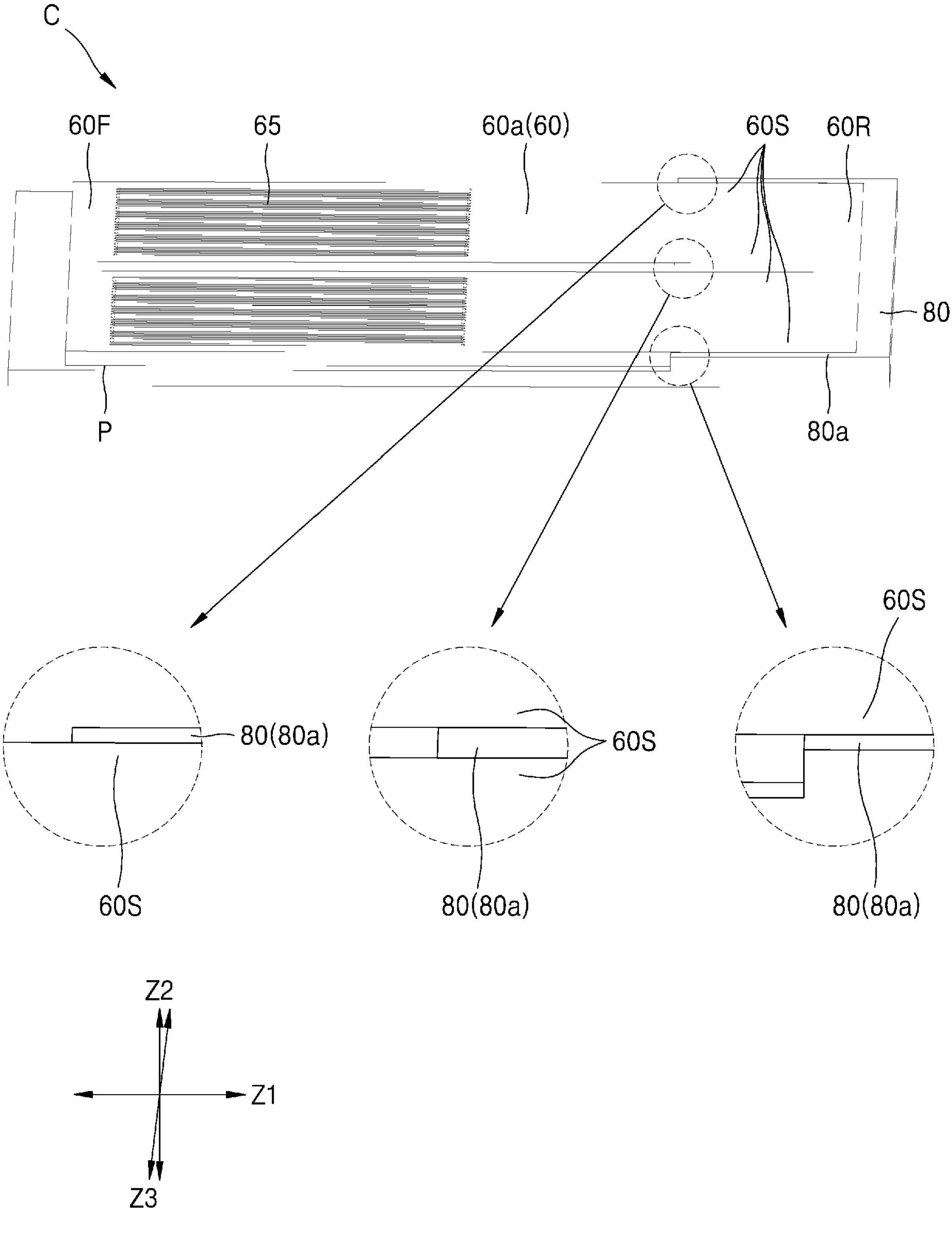
C
60F
65
60a(60)
60S
60R
80
P
80a
80(80a)
60S
60S
80(80a)
60S
80(80a)
Z2
Z1
Z3

FIG. 8A

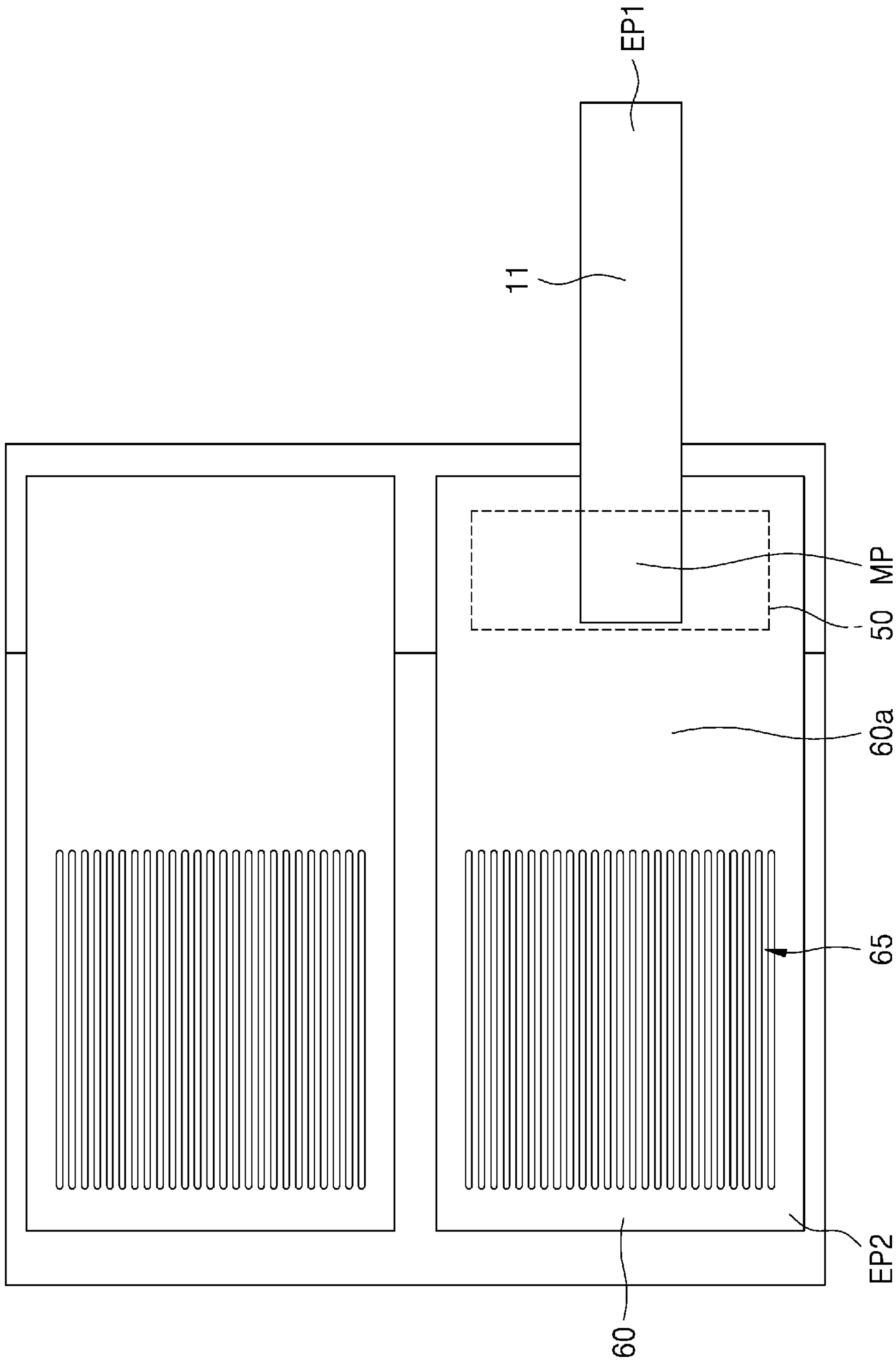

FIG. 8B